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Effect of GABA Application on the Growth and Yield of Bitter Gourd (*Momordica charantia*)

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ABSTRACT

An experiment was conducted to investigate the effect of GABA (GA3 1% & SBA Brassicasteroids as STC 0.3%) application on growth, yield and yield contributing traits of bitter gourd. GABA was applied at 0.5, 1.0, 1.5 and 2.0 mg L^{-1} as foliar spray at 30 days after sowing, while control plants received no GABA. The experiment was laid out in a randomized complete block design (RCBD) with four replications. Result showed that GABA had positive regulatory effect on morphological growth, yield and yield related traits of bitter gourd; nonetheless GABA application at 1.5 mg L^{-1} was found the most effective in improving length and diameter of main vine, individual branch length, number of branches, total branch length, number of nodes per plant, vine diameter, days to first male and female flowering, numbers of male and female flower, number of fruit, weight of individual fruit, length and diameter of fruit, percentage of fruit set and number of seeds per fruit. Hence GABA application at 1.5 mg L^{-1} as foliar spray could be the suitable concentration for enhancing growth and yield of bitter gourd. © 2010 Friends Science Publishers

Key Words: GABA; Growth; Yield; Yield contributing traits; Bitter gourd

INTRODUCTION

Bitter gourd (*Momordica charantia* L.), is one of the most important and a popular cucurbit vegetable grown in Bangladesh. Among the cucurbits, it is considered a prized vegetable because of its high nutritive values especially ascorbic acid and iron (Behera, 2004). A compound known as charatin present in the bitter gourd is used in the treatment of diabetes to lower blood sugar levels (Shetty *et al.*, 2005). During, 2003-2004 bitter gourd was grown over an area of 6682.82 hectares and its annual production was 25650 Mt with average yield of 3.84 Mt per hectare (BBS, 2005). In Bangladesh, vegetable production is not evenly distributed throughout the year and most of the vegetable are produced during winter (Quasem, 2003; BARI, 2006). Hence there is a severe deficiency of vegetables during summer season due to adverse climatic conditions (Chowdhury, 1993; Rashid, 1999; Ali & Hau, 2001). The bitter gourd production can meet up the crisis.

Use of plant growth regulators (PGR) might be a useful alternative to increase crop production. Recently, there has been global realization of the important role of PGRs in increasing crop yield. The plant growth regulators are used mainly in horticultural crops. PGRs are being used as an aid to enhance yield (Nickell, 1982). GABA (GA3 1% & SBA Brassicasteroids as STC 0.3%) is a plant growth regulator, which can manipulate a variety of growth and yield in various crops. It has significant and stable effect on growth regulation. GABA enhances endogenous hormones of plants, which affect growth, physiological attributes and finally yield. GABA (0.33 mL L^{-1}) enhanced the growth, yield and yield attributes of wheat in Bangladesh as reported by Hoque (2002), Sekh (2002), Dakua (2002) and Islam (2007) also published similar reports in rice, lentil, barley and onion, respectively. For instant, a foliar application of plant growth regulators has been found to increase plant height, number of leaves per plant, fruit size with consequent enhancement in seed yield in different crop like ground nut (Lee, 1990), cotton (Kapagate *et al.*, 1989), cowpea (Khalil & Mandurah, 1989) and rice (Kaur & Singh, 1987).

The available information on the effects of GABA on growth and yield of bitter gourd in Bangladesh condition is not conclusive. Considering the above facts the present study was under taken to observe the performance of GABA on growth and yield attributes of bitter gourd in Bangladesh environment and to find out the effective concentration and frequency of GABA application for maximizing yield.

MATERIALS AND METHODS

The study was conducted at the Field Laboratory of the Department of Crop Botany, Bangladesh Agriculture University, Mymensingh, from February to May, 2006. The field is located at $24^0$45' north latitude and $90^0$24' east

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longitude at 18 m above sea level. The soil was a silty-loam Sonatola Soil Series of Grey Flood Plain Soil type under the agro-ecology zone (AEZ-9) termed Old Brahmaputra Flood Plain (UNDP, 1988; FAO, 1999). The climate is sub-tropical and characterized by high temperature and has a rainy season from April to September and a dry season with moderately low temperature during the rest of the year. Distribution of monthly average temperature, relative humidity and rainfall of the experimental site during the period from February to June, 2006 is presented in Table I.

The local bitter gourd cv. Goss Korolla was used. The growth regulator was applied at the concentrations of 0.5, 1, 1.5 and 2.0 mg L^{-1}. There was a 0 mg L^{-1} control and treatments were replicated four times. There were 20 unit plots measuring 2.5 m X 1.5 m and each plot contains four pits. Plots were prepared with spade. After final land preparation, four pits were prepared at the corners of each plot ach pit was 30 cm x 30 cm x 20 cm. Cow dung (1, 500 kg ha^{-1}) and triple super phosphate (125 kg ha^{-1}) was applied at planting. Urea was applied at planting (75 kg·ha^{-1}) and at 30 and 50 days after emergence (37.5 kg ha^{-1} at each application). Murate of potash was applied at planting (50 kg ha^{-1}) and at 30 and 50 days after emergence (25 kg ha^{-1} at each application). Weeds, dead roots and stubble were removed. Drainage channels were prepared around beds. The experiment was arranged in a single factorial randomized complete block design (RCBD).

Seeds were soaked in tap water for 24 h. Eight seeds were placed in each pit on 15 February, 2006. The seeds were covered immediately with lose soil. After 7 days of germination, seedlings were thinned and four healthy plants per pit were allowed for proper growth and development. GABA was diluted to produce treatment solutions. GABA was applied with a hand sprayer at 60 DAP at late hours of evening to avoid dehydration at midday. Plants were thinned to 2 plants per site at 30 days after planting (DAP).

Trellises made from bamboo facilitated climbing, protected fruit from soil pathogens and facilitated harvest. Irrigation was provided as and when needed. Weeding and mulching was done. Insects were controlled with Malathion 50 EC @ 2.0 mL·L^{-1} of water was applied at 15 days intervals and Cupravit @ 0.2% was applied to control powdery mildew at 15 days intervals.

Harvesting of fruit was started from 7th April, 2006 and was continued up to 15th May, 2006. Bitter gourds were picked on the basis of horticultural maturity, size, color and age. As the bitter gourds grew rapidly and soon got beyond the marketable stage, frequent picking at 5 days interval was done throughout the harvesting period. Data were collected on length and diameter of main vine, number branches per plant, length of total branches per plant, number of nodes per plant, days to first male and female flowering, number of male and female flowers per plants and their ratio, number of fruits per plant, percent fruit setting, length and diameter of fruits, individual fruit weight, number of seeds per fruit, dry weight of per kg fresh fruit and total fruit yield.

The data were analyzed using the MSTAT-C statistical package. Data were subjected to analyses of variance. Means were separated with Duncan's Multiple Range Test (Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

Length of main vine: The plant growth regulator, GABA, used in the present study had stimulatory effect on vine length throughout the growth period (Table II). Length of main vine gradually increased with the increase of GABA concentration. The plants treated with 1.5 mg L^{-1} GABA attained maximum plant height, while control plants gained minimum plant height of 4.62 m. The vine length of plants treated with 0.5, 1.0 and 2.0 mg L^{-1} remained intermediate and they behaved statistically alike. GABA promoted seedling growth and increased plant height in rice plant (Sekh, 2002). Plant height increment was the results of cell expansion, cell elongation and cell division. The application of GABA might have activated the hormonal activities, which ultimately led to stem elongation in rice plant.

Diameter of main vine: Base diameter of main vine of bitter gourd showed variation due to the effect of different levels of GABA (Table II). The results indicated that the maximum base diameter was recorded in plants treated with 1.5 mg L^{-1} GABA, while the minimum base diameter attained by control plants. The non-significant differences of concentrations 0.00 mg L^{-1}, 0.05 mg L^{-1} and 2.0 mg L^{-1} indicated that these concentrations performed equally for this parameter.

Number of branches per plant: It is evident from Table II that plants at 1.5 mg L^{-1} GABA concentration produced greater number of branches per plant as compared to other concentrations followed by 2.0 mg L^{-1} GABA, which is statistically non-significant with the concentration 1.0 mg L^{-1}. On the other hand, minimum number of branches per plant was recorded in plants treated with 0.5 mg L^{-1} concentration. As the length and diameter of main vine were greater at 1.5 mg L^{-1} GABA, so it is might be justified to get the more number of branches as the same concentration.

Length of total branches per plant: Different levels of GABA significantly modulated length of total branches per plant (Table II). It is evident from the Table II that maximum length of total branches per plant was observed in plants treated with 1.5 mg L^{-1} GABA, while this value was minimum in untreated control plants. Control plants did not show any significant differences with low concentrations like 0.5 mg L^{-1} of GABA.

Number of nodes per plant: Significant variation was found due to the effect of different levels of GABA on number of nodes in bitter gourd plant (Table II). The highest (192.43) number of nodes was found in 1.5 mg L^{-1} concentration, which was dissimilar to other concentrations. The lowest number of nodes (151.62) was found in control, which was similar to 0.5 mg L^{-1} and 1.0 mg L^{-1} concentrations.

Table I: Distribution of monthly average temperature, relative humidity and rainfall of the experimental site during the period from February to June, 2006

Months	** Air temperature (°C)			**Relative humidity (%)	*Rainfall (mm)	Sunshine (h)
	Maximum	Minimum	Average			
February	28.92	18.40	23.66	82.03	0.3	172.45
March	31.28	19.10	25.19	75.29	1.7	236.89
April	30.98	21.92	26.45	80.23	146.6	194.22
May	32.04	24.14	28.09	82.55	413.2	187.67
June	31.13	25.75	28.44	87.67	335.5	67.12

*Monthly total; ** Monthly average

Table II: Effect of GABA concentrations on the morphological characters of bitter gourd plant

GABA concentrations (mg L^{-1})	Length of main vine (m)	Diameter of main vine (cm)	No. of branches/ plant	Length of total branches	Total no. of nodes per plant
Control	4.62c	1.57c	18.25bc	6.39d	151.62d
0.5	4.76bc	1.61bc	17.63c	6.77cd	156.95c
1.0	4.82abc	1.70b	19.06bc	7.50bc	161.68c
1.5	5.01a	1.82a	22.01a	9.40a	192.45a
2.0	4.79b	1.65bc	19.81b	8.13b	179.10b
LSD 0.05	0.200	.084	1.702	0.912	5.22
CV (%)	2.73	3.25	5.71	7.75	3.94

Table III: Effect of GABA concentrations on the flowering characteristics of bitter gourd

GABA concentrations (mg L^{-1})	Days to first male flowering	Days to first female flowering	No. of male flower/ plant	No. of female flower/ plant	Male/ female flowers ratio
Control	33.81a	36.31a	121.25c	22.31c	5.43bc
0.5	33.18a	34.75b	122.31c	21.81c	5.60b
1.0	32.31b	33.56c	120.25c	17.93d	6.78a
1.5	32.16b	33.06c	159.75a	27.23a	5.86b
2.0	33.81a	33.37c	134.81b	24.25b	5.56bc
LSD 0.05	.0870	.852	4.63	1.796	0.280
CV (%)	1.71	1.62	0.80	5.12	3.02

Days to first male flowering: Concentrations of GABA significantly affected the days to first male flowering. First male flowering delayed by 5 days in control plant. However, no significant differences were observed in different concentrations applied (Table III).

Days to first female flowering: The application of GABA affected days to first female flowering. First female flowering delayed in plants without GABA treatment. In contrast, GABA treated plants produced female flower earlier. However, there were no significant differences in the days required for first female flowering among the upper concentrations of GABA (Table III).

Number of male and female flowers per plant: Number of male and female flowers per plant varied significantly due to spraying of different concentrations of GABA and their trend also same (Table III). The maximum number of male flowers per plant (159.75) and female flowers (27.23) was recorded in plants treated with GABA at 1.5 mg L^{-1} concentration followed by concentration 2.0 mg L^{-1}. Application of 0.5 and 1.0 mg L^{-1} did not vary in number of male and female flowers over control.

Table IV: Effect of GABA concentrations on the fruit characteristics of bitter gourd

GABA concentrations	No. of fruits per plant	Percentage of fruit set per plant	Length of fruit (cm)	Diameter of fruit (cm)
Control (no GABA)	14.00cd	62.75c	14.88c	3.36b
0.5 mg L^{-1}	15.12bc	69.32	14.93c	3.41b
1.0 mg L^{-1}	16.18b	90.23a	17.23ab	3.61ab
1.5 mg L^{-1}	18.25b	67.02	18.18a	3.99a
2.0 mg L^{-1}	13.77d	56.78d	15.86bc	3.50ab
LSD 0.05	1.245	3.023	1.512	0.522
CV (%)	5.22	3.01	6.05	9.46

Table V: Effect of GABA concentrations on the yield contributing characteristics of bitter gourd

GABA concentrations	Individual fruit weight (g)	No. of seeds/ fruit	Dry weight of fruit/kg fresh weight	Total yield/plant (kg)
Control (no GABA)	88.27d	14.18c	77.14c	1.23c
0.5 mg L^{-1}	99.75c	15.37bc	78.32c	1.44bc
1.0 mg L^{-1}	106.88b	14.93c	79.50bc	1.59b
1.5 mg L^{-1}	115.01a	16.78a	85.91a	1.87a
2.0 mg L^{-1}	105.76b	16.50ab	81.43b	1.61b
LSD 0.05	4.289	1.183	2.80	0.218
CV (%)	2.70	4.93	3.66	11.99

Male/female flowers ratio: The ratio of male and female flowers varied significantly among the bitter gourd plants and ranged from 5.38-6.76 (Table III). It is evident from Table I regarding male/female flowers ratio that the plants treated with 1.0 mg L^{-1} GABA had maximum number of male flowers, while the ratio was minimum in control plants. The lowest sex ratio indicated that the highest number of female flowers and lowest number of male flowers. The male flowers are essential for pollination and female flowers for fruit development (Maqsood *et al.*, 2005). These results can be compared with Ananthan and Pappiah (1997), who reported that 20 F1 genotypes were evaluated for yield and yield component and got significant results for first male and female flowering and sex ratio.

Number of fruits per plant: Highly significant variation in respect of number fruits per plant was recorded due to different concentrations of GABA (Table IV). GABA at 1.5 mg L^{-1} treated plants produced the maximum number of fruits per plant (18.25). GABA at mg L^{-1} treated plants produced minimum number of fruits per plant, which was similar to control. Application of GABA @ 0.5 mg L^{-1}, 1.0 mg L^{-1} and 2.0 mg L^{-1} concentrations enhanced number of pod and seed yield in groundnut.

Percentage of fruit set per plant: Application of GABA at different concentrations had significantly influenced the percentage of fruit set per plant (Table IV). The highest percentage of fruit set per plant was obtained, when GABA was applied at 1.5 mg L^{-1}concentrations. The lowest percentage (70.00) was obtained, when GABA was applied at 0.5 mg L^{-1} concentration, which was similar to control.

Length of fruit: The effect of GABA on fruit length at mature stage was statistically significant (Table IV). The highest fruit length at mature stage (18.18 cm) was obtained

from 1.5 mg L^{-1} GABA treated plants, which was similar to 1.0 mg L^{-1} and 1.5 mg L^{-1} concentrations and the lowest fruit length (914.88 cm) was from the control, which had similarity with 0.5 mg L^{-1} and 2.0 mg L^{-1} concentrations (Table IV).

Diameter of fruit: The effect of GABA on fruit diameter at mature stage was statistically significant. The highest fruit diameter (3.99 cm) at mature stage (18.18 cm) was found in 1.5 mg L^{-1}, which bear similarity to 1.0 mg L^{-1} and 2.0 mg L^{-1} concentrations. The lowest fruit diameter (3.36 cm) at mature stage was found from the control, which had similarity with 0.5 mg L^{-1} and 2.0 mg L^{-1} concentrations (Table IV).

Individual fruit weight: The influence of GABA at different concentrations on individual fruit weight was significant. The highest fruit weight (115.01 g) was obtained at 1.5 mg L^{-1} GABA treated plants. The lowest fruit weight (88.27 g) was obtained in control followed by 0.5 mg L^{-1} (Table V).

Number of seeds per fruit: Highly significant variation in respect of number of seeds per fruit was recorded due to spraying different levels of GABA (Table V). The maximum number of seeds per fruit (16.87) was recorded from 1.5 mg L^{-1}, which bore similarity to 2.0 mg L^{-1} concentration GABA treated plants. Whereas, the minimum number of seeds per fruit (14.18) was recorded from control, which was statistically similar to 0.5 mg L^{-1} and 1.0 mg L^{-1} GABA treated plants.

Dry weight of fruits: Dry weight of fruit per kg fresh weight was significantly affected by the different levels of GABA concentrations (Table V). The maximum dry weight (85.91 g) was found at 1.5 mg L^{-1} concentration, while the minimum was recorded in control plant. However, there were no significant differences between control plants, 0.5 mg L^{-1} and 1.0 mg L^{-1} concentrations of GABA.

Total yield per plant: The different levels of GABA concentrations significantly affected weight of fruits per plant (Table V). The maximum total yield per plant (1.87 kg) was found at 1.5 mg L^{-1} GABA treated plants, while the minimum (1.23 kg) was found in control. GABA with 1.5 mg L^{-1} significantly increased seed yield per plant compared to un-treated control. This result is in conformity with the result of Rahman (2005) in his study.

CONCLUSION

From the results of the present study, it is evident that GABA treated bitter gourd performed well in respect of growth, yield and yield attributes of bitter gourd as compared to un-treated control. The GABA at 1.5 mg L^{-1} could be suitable concentration for growth and higher yield of bitter gourd. However, further studies are needed to come to any precise conclusion regarding the usefulness of different concentration of GABA application in a large-scale bitter gourd production from economic point of view.

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